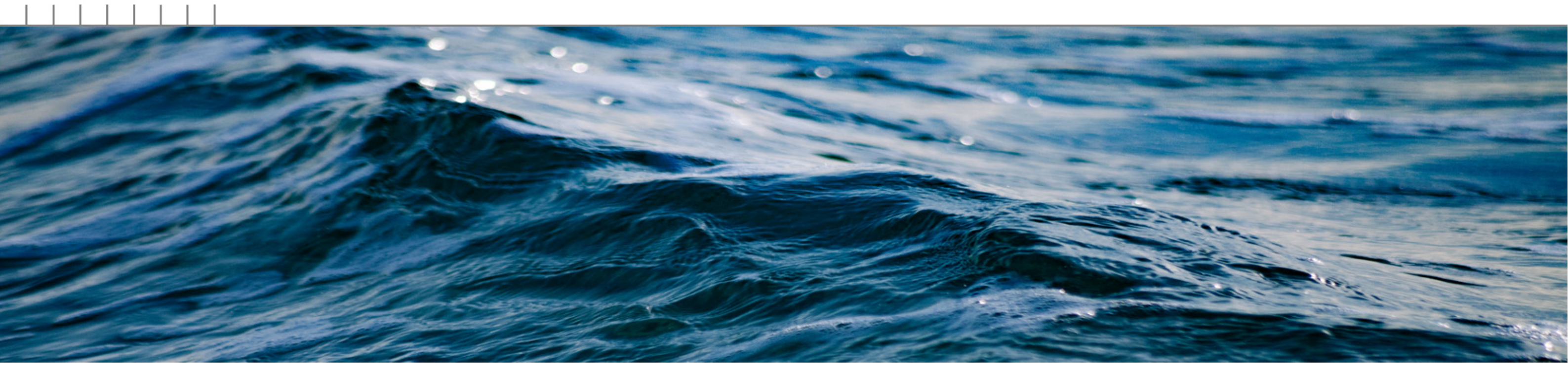
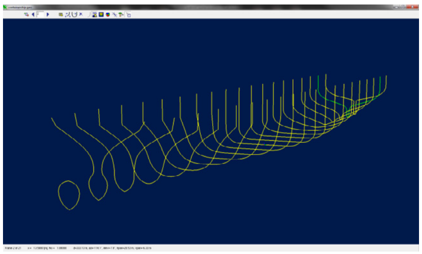


SHIPMO

Fast seakeeping calculations: behaviour of a ship in a seaway

At MARIN the program SHIPMO is available for the calculation of the behaviour of a ship in a seaway. The program is based on the well-known 'strip theory'.

The added resistance in waves can be calculated by four approximation methods: Gerritsma/Beukelman, Boese, Salvesen and a combination of these methods. The program also accommodates multihulls such as catamarans and trimarans



Computational approach

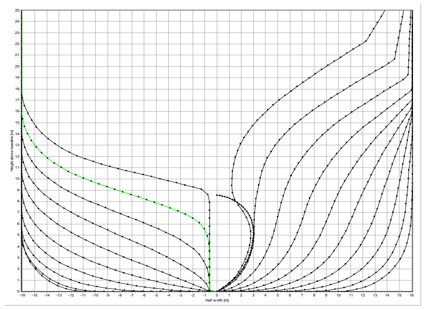
The potential theory underlying SHIPMO assumes slenderness of the ship's hull and linearity of the hydrodynamic forces. The assumption of slenderness opens up the opportunity for a 2-D 'strip-wise' solution of the hydrodynamic forces in waves. The assumption of linearity implies that in principle the results are valid for relatively small motions only and that the ship is supposed to have vertical sides. The program is actually split up into two parts. In the first part the hydrodynamic forces are calculated. In the second part the equations of motion are solved.

The hull form is approximated by an arbitrary number (usually 20-40) of frames or sections. Each section shape is approximated by a number of line elements. It is assumed that there is no direct hydrodynamic interaction between the sections. The ship-wave interaction problem is described as the superposition of two smaller problems: a fixed ship in incoming and diffracted waves (the diffraction problem) and a moving ship in radiated waves (the radiation problem). For each section, the fundamental radiation-diffraction problem is solved and the corresponding hydrodynamic forces are calculated.

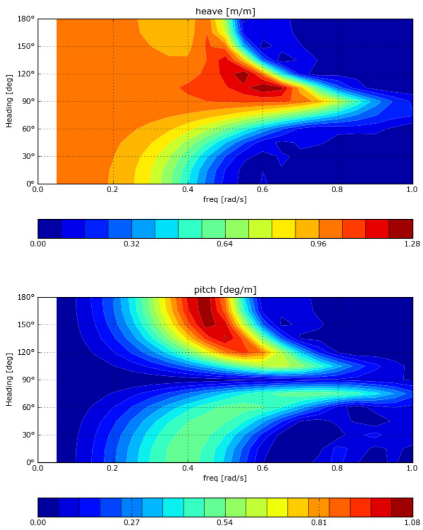
After evaluation of the wave excitation forces and the reaction forces on the individual sections, the global forces are obtained by integration over the ship length. The integration can also be carried out for a segment of the ship. The wave excitation forces are composed of the incoming (or Froude-Krylov) wave forces and the diffraction wave forces. The reaction forces are expressed in terms of added mass and damping coefficients.

In the second part of the program the equations of motion are solved. Several options exist to include the nonlinear effects of:

- viscous roll damping due to the generation of eddies around the bilge, skin friction damping, lift damping
- flow around bilge keels and skegs
- fin and rudder stabilisers, both passive and active
- anti-roll tanks



Strip-wise geometry description of container ship



Heave (top) and pitch (bottom) motion of container ship in regular waves

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Input

- body plan
- draft at aft and fore perpendiculars, transverse metacentric height
- mass distribution, radii of gyration
- appendages: bilge keels, skegs, fins, rudders
- ship speeds
- regular waves: wave directions, wave frequencies, water depth
- irregular waves: significant wave height and wave period

Output

- motions: surge, sway, heave, roll, pitch and yaw
- response in reference points:
  - relative vertical motion and velocity
  - absolute motions, velocities and accelerations
- internal loads at transverse cuts:
  - transverse and vertical shear forces and bending moments, torsional moment
- added resistance in waves

All results are available in the form of Response Amplitude Operators (RAOs) in the frequency domain. To obtain a meaningful interpretation of the motion characteristics the results have to be combined with wave climate and motion criteria. An interface with the program WASCO was developed to facilitate an efficient handling at this part of the analysis.

Applications

Despite the theoretical limits of linear strip-theory the program is used for a wide range of applications and hull forms. The most important applications are:

- prediction of seakeeping behaviour in initial design
- comparison of hull forms
- evaluation of the performance of roll stabilisers
- optimization of experimental programs; e.g. by a rational selection of heading, speed, wave height and period

The use of SHIPMO has yielded a large volume of valuable information. In general it can be concluded that the over-all motions of various ship types in waves of limited height are predicted with fair accuracy. The main limitations are the prediction of:

- the roll response
- the relative wave elevation in the ship's sides due to 3-dimensional effects
- the added resistance in short waves or in beam and stern quartering waves
- the behaviour in extreme conditions